



## Research article

## Public trust and knowledge in the context of emerging climate-adaptive forestry policies

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## ABSTRACT

Effective governance of public forests depends, in part, on public support for changes in forest management, particularly those responding to changes in socio-ecological conditions driven by climate change. Trust in managing authorities and knowledge about forest management have proven influential in shaping public support for policy across different forest management contexts. However, little is known about the relationship between public trust and knowledge as it relates to policy support for emerging management strategies for climate adaptation in forests. We use the example of genomics-based assisted migration (within and outside of natural range) in British Columbia's (BC) forests to examine the relative roles of and interactions between trust in different forestry actors and knowledge of forestry in shaping public support for this new and potentially controversial management alternative. Our results, based on an online survey ( $n = 1953$  BC residents), reveal low public trust in governments and the forest industry combined with low levels of public knowledge about forest management. We find that individuals who are more trusting of decision-makers and other important forestry actors hold higher levels of support for assisted migration. Higher levels of forestry knowledge are linked with support for assisted migration within native range, whereas no knowledge effect is observed for assisted migration outside of native range. We discuss the implications of these observations and provide recommendations to more fully engage with the challenges of low levels of trust and knowledge in this context.

## 1. Introduction

New and potentially controversial environmental management actions are increasingly proposed to help adapt forests to the impacts of climate change (Hagerman and Pelai, 2018). Genomics-based assisted migration—the intentional movement of tree species to more suitable areas (within or outside of native range) based on climatic projections and genetically-informed seed selection—is one such management strategy (Park and Talbot, 2012; Aitken and Whitlock, 2013). For public forests, which comprise approximately three-quarters of the world's forested landcover (FAO, 2018), effective forest governance relies on strong public support and acceptance of forest policies (McFarlane et al., 2012; Nelson et al., 2017). Accordingly, the potential implementation of genomics-based assisted migration and other climate-adaptive strategies requires strong public acceptance. Yet decades of controversies over forest practices and poor conservation outcomes (Agrawal and Gibson, 1999; FAO, 2016a, b) have, in general, led to an erosion of public confidence in forest management (Nelson et al., 2017; Cashore et al., 2001; Spies and Duncan, 2012).

Two factors in particular, trust in managing authorities and knowledge of the phenomena in question (reviewed in greater detail below), tend to be implicated as crucial determinants of public support for environmental challenges, particularly when the issues involve managing commons resources located on publicly managed land (Ostrom, 2009). Low public trust in government, for instance, is often correlated with reduced support for forest management (Winter et al., 2004; Wynveen and Sutton, 2015; Stern, 2008) and other environmental policies relating to climate change (Kellstedt et al., 2008). In addition, some studies have found that limited public knowledge—while more complex in its role—can accentuate this effect (Siegrist and Cvetkovich, 2000; McFarlane et al., 2012). Here, we contribute to the literature on climate adaptive forest management (Aubin et al., 2011; Pedlar et al., 2012; Vitt et al., 2010; Hagerman and Pelai, 2018) by examining the roles of public trust and forestry knowledge as potential drivers of support for new management alternatives on public land.

This study focusses on genomics-based assisted migration both within and outside of native range. In British Columbia (BC), Canada, genomics-based assisted migration within range (sometimes referred to

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as assisted gene flow) is being trialed as a management strategy for widespread implementation in the immediate future (O'Neill et al., 2017; Government of BC, 2017). The potential adoption of this strategy would represent a substantial change in management in a province where 95% of forested land is publicly owned and the forestry sector plays a major economic role (BC MFLNRO, 2017). While assisted migration is endorsed as necessary by many scientists and practitioners (Ste-Marie et al., 2011), this approach has its critics amongst scientists (McLachlan et al., 2007; Aubin et al., 2011) and publics (Hajjar and Kozak, 2015; Peterson St-Laurent et al., 2018b). In part, hesitation across these groups arises from the myriad scientific, climatic and ecological uncertainties associated with this management approach (Park and Talbot, 2012; Pedlar et al., 2012), as well as latent mistrust in forest management more broadly (Findlater et al., 2018).

Considering the known, yet variable, relationships that exist between public trust, knowledge, and policy support for environmental management dilemmas broadly, and the specific momentum for assisted migration in BC's publicly-owned forests, the objective of this study is to understand the potential roles/non-roles of trust and knowledge in shaping support for assisted migration in BC's forests. We address the following questions:

1. What do British Columbians know about forest management?
2. Who do British Columbians trust to provide accurate information about climate change and to select the most appropriate forest management interventions in the public interest?
3. What is the nature of the relationship between knowledge of forest management, trust and support for assisted migration?

Further, we evaluate the effects of demographic and psychographic factors (including perceptions of climate change) in predicting levels of trust and knowledge of forest management.

## 2. Public trust, knowledge and support for forest management

The risk governance literature consistently identifies public trust as a key determinant of perceived risk under uncertainty, and one of the most important factors influencing public support for forest management in general (Eriksson et al., 2017; Ford et al., 2012; Nelson et al., 2017; Stern and Baird, 2015). The relationship between public trust and public support has been demonstrated in the context of forest certification (Sasser et al., 2006), climate change mitigation interventions in forests (Peterson St-Laurent et al., 2018a), and the management of forest fires (Toman et al., 2014; Olsen and Shindler, 2010; Winter et al., 2004) and pests (Qin and Flint, 2010; McFarlane et al., 2012). One of the key insights arising from this field is the observation that high levels of public trust can help reduce conflicts and increase the ability of communities to organize and implement new forest management strategies (Olsen and Shindler, 2010). While much of the literature focusses on public trust in government and public agencies (Olsen and Shindler, 2010; Winter et al., 2004), other studies highlight the role of public trust in non-governmental groups including forest industry (McFarlane et al., 2012; Eriksson et al., 2017) and environmental non-governmental organizations (NGOs; Sasser et al., 2006).

In addition to trust, the role of knowledge in shaping perceived risk and policy support has occupied the attention of risk governance scholars and others working at the science-policy interface (Pidgeon and Fischhoff, 2011). One school of thought views the relationship between knowledge and policy support as linear. This “knowledge-deficit model” holds that resistance to science and technologically-based management solutions originates from a lack of familiarity and information (Brown, 2009; Bauer, 2009). Accordingly, the assumption is that educating the public about an environmental issue should enhance public support (Dickson, 2005). However, empirical support for knowledge as a predictor variable (i.e., of support for policies) is much more nuanced (Brown, 2009; Kellstedt et al., 2008; McFarlane et al.,

2006). While some studies report inconclusive effects of knowledge (Hajjar and Kozak, 2015; McFarlane and Boxall, 2000; McFarlane, 2005), others show a significant relationship between some dimensions of climate knowledge (e.g. cause of climate change) and risk perception, but not others (e.g. physical characteristics of climate change) (Shi et al., 2016). Based on a study of the effects of scientific literacy and education on beliefs in the United States regarding six controversial topics including climate change, Drummond and Fischhoff (2017) found that science literacy may enable the defence of positions derived from non-scientific motivations, corroborating “the motivated reasoning account, by which more knowledgeable individuals are more adept at interpreting evidence in support of their preferred conclusions” (p.9590). Combined, these studies suggest that while knowledge—or more specifically, certain types of knowledge—may play a role in shaping support in some contexts, other factors (e.g., political and religious views, cultural values) often have a greater influence on public opinion (Sturgis and Allum, 2004; Kahan et al., 2012; Eden, 1998). Considering the known, but complex roles of trust and knowledge as characterized in other risk contexts, we evaluate how these two factors shape support for assisted migration in forest management in BC.

## 3. Methods

### 3.1. Case study: assisted migration in British Columbia's public forests

In BC, like many other jurisdictions in Canada, forest management has historically responded to the needs of the forest industry (Howlett, 2001; Cashore et al., 2001). As public interest in environmental values and public participation in forest management has increased over time, BC's forestry sector has moved from a bilateral government-industry “partnership” towards a multi-stakeholder approach characterized by the participation of a broader range of actors, including elected and unelected officials, the forest industry, forest professionals, environmentalists, First Nations, actors involved in certification schemes and the general public (Howlett et al., 2009; Luckert et al., 2011). The importance of engaging with the public is reflected in the government's objective to “strengthen public trust in natural resource management practices by promoting values-based decision making principles and engaging with stakeholders and communities” (BC MFLNRO, 2017). The government also notes the importance of educating the public, stakeholders and Indigenous peoples about climate change adaptation, particularly in terms of “build[ing] a strong foundation of knowledge and tools to help public and private decision-makers across BC prepare for a changing climate” (BC MFLNRO, 2017).

Despite these apparent shifts towards broader participation, others argue that the BC public continues to be dissatisfied with public participation in forest management decision-making (Tindall et al., 2010). Supporting this claim, Peterson St-Laurent et al. (2018a) recently found high levels of public mistrust in governments when it comes to providing information on climate change issues in BC's forests. This mistrust in the way the government manages forests and involves the public, coupled with high levels of scientific uncertainty associated with climate change adaptation in the forests, is the backdrop against which the BC government is piloting assisted migration on public lands.

### 3.2. Data collection

Data was collected from an online survey exploring public views on potential reforestation strategies for climate change adaptation in BC's forests, including assisted migration. We gathered 1953 completed surveys<sup>1</sup> between May 15 and 30, 2018 using the online research panels

<sup>1</sup> An additional 174 surveys were excluded from the analysis because they were answered in less than 8 min, the minimum time deemed required to fill out the survey during pre-testing.

of the digital data collection company *ResearchNow*. Here, we report on 56 continuous, ordinal scale, multiple choice and open-ended questions to evaluate the BC public's knowledge about forest management, trust towards various groups and support for different reforestation strategies including assisted migration.

One of the limitations of online surveys is restricted sampling availability (i.e., certain individuals are less likely to complete online surveys), which can lead to underrepresentation of certain groups of individuals (Blair and Czaja, 2013; Wright, 2005). To avoid underrepresentation of segments of BC's population within the sample, we prescribed quotas based on the latest population census (2011) for age, gender and population in large urban centres (i.e., Victoria and Vancouver). The survey was extensively pre-tested multiple rounds of pilot testing with diverse individuals (e.g., government representatives, students, members of the public) to ensure clarity of the survey's illustrations, descriptions and questions. The survey included multiple opportunities throughout—in the form of open text fields—for respondents to detail and clarify their responses, and add further comments.

The survey began with an overview of climate change and its impact on BC's forests. This was followed by questions about demographics and perceived causes of, and risks associated with, climate change (treated here as independent variables). To evaluate public perceptions of climate risk, participants indicated (on a 5-point ordinal scale from not at all (0) to extremely (4)) how serious a threat they thought climate change would be within the next 25 years to: (i) them personally, (ii) people in BC, (iii) BC's natural environment, (vi) the world's population and (v) the world's natural environment. This spectrum allowed us to evaluate differences in perspectives between the potential impacts of climate change at personal, regional and global scales. We also used this data to assign an aggregated average index on risk perception of climate change to each respondent. We adapted a question from Leiserowitz et al. (2017) to assess respondents' belief on the causes of climate change. We then created a binary variable with two factors, regrouping either respondents who think that climate change is “mostly caused by human activities” or by all the other response options<sup>2</sup>.

To measure knowledge and trust among BC's public, we collected data on: (i) different dimensions of knowledge about forest management and (ii) trust in government and non-governmental actors involved in forest management. We assessed respondents' knowledge of forest management in BC with 10 true or false questions (a “not sure” option was also provided) that covered reforestation (four questions), economics of forestry (four questions) and two questions on forest ownership. For each respondent, we calculated aggregated indices for all questions (out of 10), as well as for knowledge on reforestation and economics (out of 4) by summing the results of the individual questions, where a correct answer = 1 and an incorrect answer or “not sure” = 0. Second, we asked participants to rate the extent to which they trusted different groups to provide accurate information about the implications of climate change for forest management on a 5-point ordinal scale from not at all (0) to extremely (4). We also asked respondents to indicate their levels of agreement—on a 5-point ordinal scale from strongly disagree (−2) to strongly agree (+2)—with the statement, “I trust decision-makers to choose the interventions that would work in the best interest of British Columbians.”

Finally, respondents were introduced to the concept of assisted migration within and outside of natural range using illustrations and textual descriptions (Appendix 1). Respondents were informed that these strategies are currently being considered for implementation by the BC government. We asked respondents to indicate their levels of

support for both types of assisted migration using a 5-point ordinal scale from strongly oppose (−2) to strongly support (+2), with an unsure option (0).

### 3.3. Data analysis

We conducted all of the statistical analyses in R Studio (version 1.0.153, <http://rstudio.org/>). We used descriptive statistics (i.e., means and frequencies) to summarize the data. We treated individual interval scales as ordinal variables and, therefore, used non-parametric statistical analysis (e.g., Kruskal-Wallis test), whereas we analysed composite scales, created by summing rating scale questions, with parametric statistics (e.g., paired t-test). We used factor analysis on the trust data to reduce the number of actors into a smaller number of categories, extracting factors with eigenvalues of greater than 1. We used a minimum loading of 0.50 to distribute the items within each factor and created new aggregated indices by averaging the scores of the items that loaded in each category. We calculated a Cronbach's alpha reliability coefficient ( $\alpha$ ) to ensure internal consistency of the new scales. We carried out multiple linear regressions to evaluate the effects of the independent variables (i.e., demographics and perception of climate change) on the aggregated levels of knowledge of forestry and levels of trust for the categories of actors identified in the factor analysis. Multiple linear regression analysis was the appropriate model for the continuous scales generated by the factor analysis of trust in different actors. Notably, trust in professional foresters is treated separately, since this variable did not load strongly enough onto the two main factors. Although this dependent variable is measured using an ordinal scale, we nonetheless analysed it using linear regression so that we could compare the results with those of the two other categories of actors. Finally, we carried out ordinal logistic regressions to evaluate the contribution of public trust and knowledge of forest management on levels of support for both types of assisted migration.

## 4. Results

An overview of participants' demographics can be found in Appendix 2. Overall, respondents reported that climate change poses a serious threat—averaged across the five questions, 82% of respondents perceived it to be moderately serious or higher, with only 4% saying that it represented no threat (Fig. 1). There were significant differences in the perceived threat of climate change across spatial scales (Kruskal-Wallis:  $H(4) = 777.54$ ,  $p < 0.001$ ), increasing from personal to global, meaning that the BC public generally perceive climate change as a distant threat. More than half of the respondents (54%) indicated that climate change is mostly anthropogenic (see Appendix 3 for detailed distribution), while 42% indicated that climate change is equally or mostly caused by natural changes in the environment.

Respondents' knowledge of forest management was low and highly variable. Out of ten true/false questions, respondents correctly answered an average of four ( $SD = 2.20$ ; Fig. 2). The question that was most often answered correctly (57% of respondents) was that “even though about 95% of BC's forests are publicly owned, logging rights are mostly transferred to private companies” (true). In contrast, only 15% of respondents correctly responded to the statement that “forest policy in BC allows for genetically modified trees to be planted on public land” (false). We used a Student's t-test to compare mean responses to questions on reforestation issues ( $M = 1.60$ ,  $SD = 1.14$ ) versus questions on forestry economics ( $M = 1.62$ ,  $SD = 1.06$ ). Because we found no significant difference between these two types of forestry knowledge ( $t(1925) = 0.91$ ,  $p = 0.37$ ), we used only the aggregated forestry knowledge score in further statistical analyses.

The variation in performance on individual knowledge questions indicates different levels of public knowledge about different aspects of forestry. On the one hand, a majority of respondents were aware that most of BC's forests are publicly owned, that the responsibility and right

<sup>2</sup> The other options included: (i) caused mostly by natural changes in the environment, (ii) caused equally by natural changes in the environment and human activities, (iii) not caused by natural or human activities, because climate change isn't happening, (iv) other or (v) I don't know.

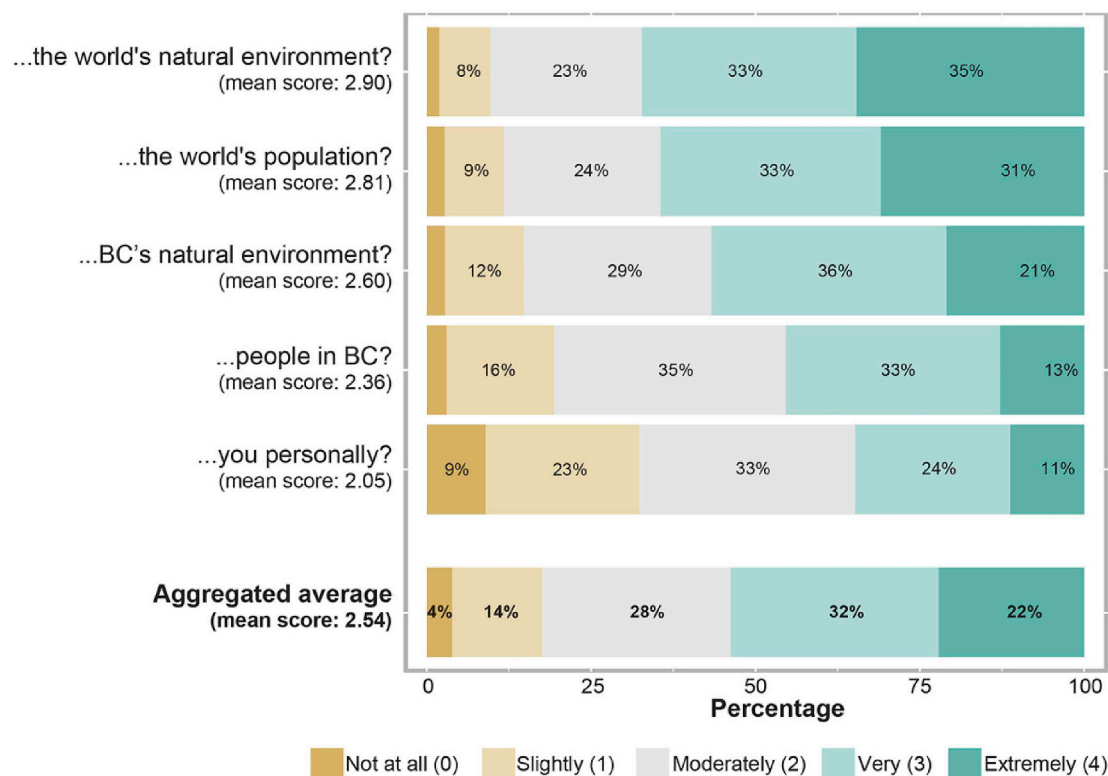


Fig. 1. Perceptions of how serious of a threat climate change is from global to local scales, with 0 = not at all and 4 = extremely.

to manage, harvest and use forest resources is commonly delegated to the private sector through a system of licensing arrangements (for more details, see Luckert et al., 2011) and that forestry represents a fundamental component of BC's economy. On the other hand, public knowledge was low for questions related to reforestation and the use of genetically modified trees on public lands. Most respondents also incorrectly believed that logs, as opposed to processed wood products, account for the majority of the BC forest industry's exports. Only 15% of respondents were aware that most of the Indigenous peoples' traditional territory in BC is unceded and without treaty (for more details, see BC Treaty Commission, 2018).

With respect to trust, respondents had differing opinions—only about one third agreed (32%) or strongly agreed (5%) with the statement, “I trust decision-makers to choose the interventions that would work in the best interest of British Columbians.” A slightly smaller proportion of respondents disagreed (20%) or strongly disagreed (7%) with the same statement, while 36% indicated their neutrality. Many respondents entered comments in the optional text fields that highlighted their lack of trust in the government. For example; “I don't have much faith that the outcomes [of scientific research on assisted migration] will be adopted by government.”

There were also significant differences between respondents' levels of trust in the ability of different actors to provide accurate information about the implications of climate change for forest management

(Kruskal-Wallis  $H(7) = 15.4$ ,  $p = 0.03$ ; Fig. 3). *Post hoc* Dunn's pairwise tests indicated that all mean responses were significantly different from each other except for those for the provincial and federal governments ( $p = 0.09$ ). Scientists were, by far, the most trusted group, with 60% of respondents indicating scientists as “very” or “extremely” trustworthy. Multiple respondents commented that scientists or other experts should be the ones making decisions about forest management. For example; “I hope that before any radical changes are done to the current reforestation policy, it is tested and looked at very closely by foresters and scientists.” In contrast, only 6% of respondents deemed the private sector or industry to be “very” or “extremely” trustworthy.

The factor analysis (Table 1) identified two clusters of actors who exhibited shared response patterns on the question of trust. Except for professional foresters (loading of 0.443 and 0.206), all actors clearly loaded into one of the two factors. The first cluster included the provincial and federal governments and the forest industry. This group of actors personifies the dominant government-industry “partnership” found in the forest sector prior to the recent shift in governance, and we hereafter refer to them as the “traditional forestry actors.” Multiple respondents expressed deep suspicion of this “partnership” in their comments. For example; “The ‘secrets’ [of the forest industry] are kept by the industry and the government. The industry and the government do not want average people to know what is going on, and who profits from it.” While professional foresters obtained a fairly high loading into the



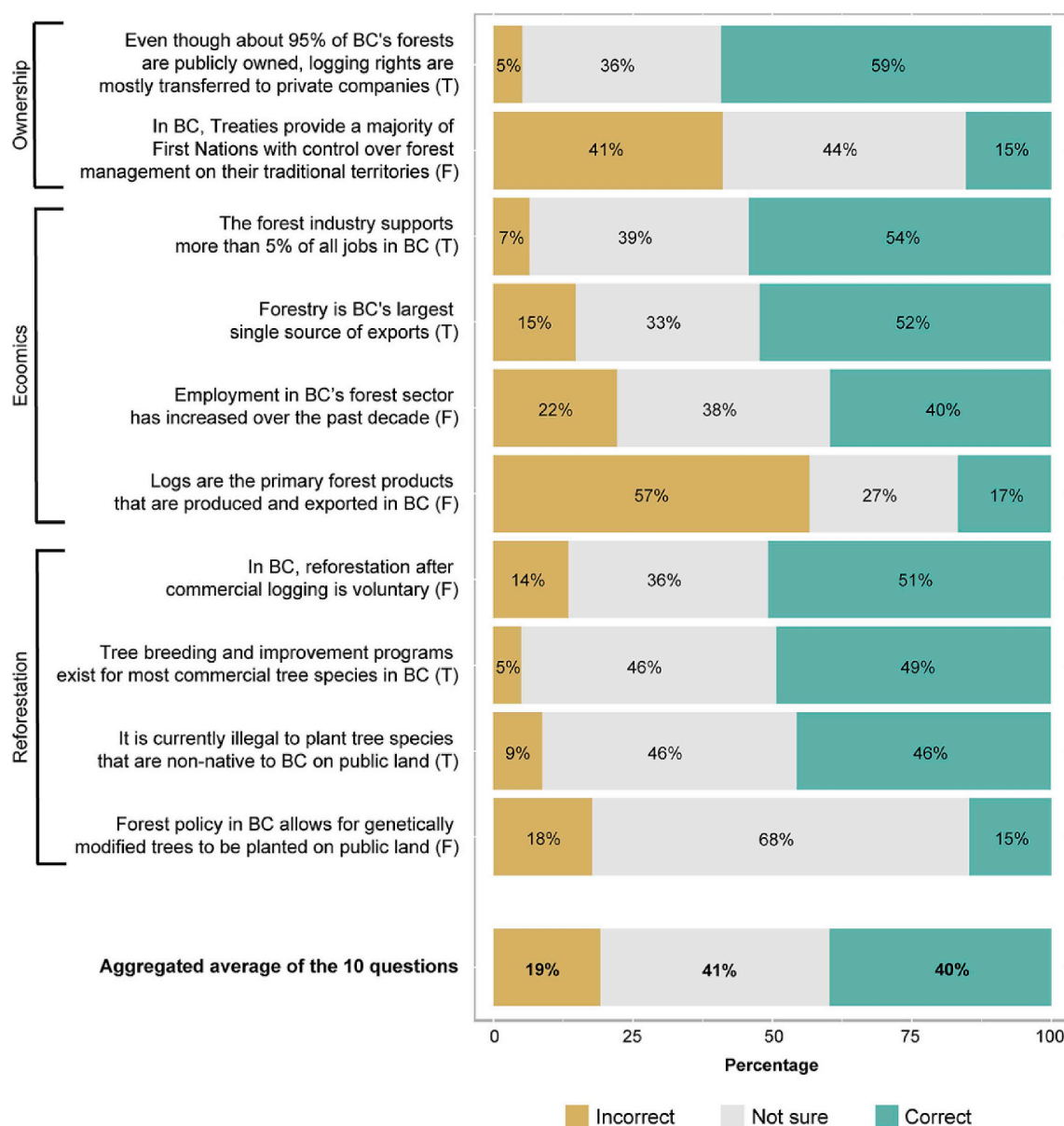


Fig. 2. Overview of the results of the individual true/false questions to assess respondents' levels of knowledge with forest management in BC.

traditional forestry actors grouping (loading of 0.443), the fact that they not clearly loaded into the factor points to their ambiguous and evolving role in managing publicly-owned forests and suggests that the public makes a distinction between governments and the forest industry on the one hand, and practicing foresters—who may or may not be employed by these institutions—on the other. The second group included First Nations leaders, environmental groups and scientists—actors who have recently gained more influence and authority in forest management decisions (hereafter called “emergent forestry actors”). On average, respondents were more trustful of emergent forestry actors ( $M = 2.17$ ,  $SD = 0.89$ ,  $\alpha = 0.76$ ) than of traditional forestry actors ( $M = 1.47$ ,  $SD = 0.79$ ,  $\alpha = 0.83$ ;  $t(1925) = 33.162$ ,  $p < 0.001$ ).

We used multiple linear regressions to evaluate the effect of demographic variables on knowledge of forestry and trust in the two actor groups and professional foresters (Table 2). Although the F-values of the four multiple linear regression models were significant and the significant variables that the models extracted were similar, the regression model predicting trust in emergent forestry actors (adjusted  $R^2 = 0.39$ ) better explains the variance in the data than do the models for trust in traditional forestry actors (adjusted  $R^2 = 0.06$ ) and professional foresters (adjusted  $R^2 = 0.05$ ), as well as for aggregated knowledge (adjusted  $R^2 = 0.08$ ).

Urbanites, women and younger individuals had significantly lower forestry knowledge, while respondents who were more highly educated

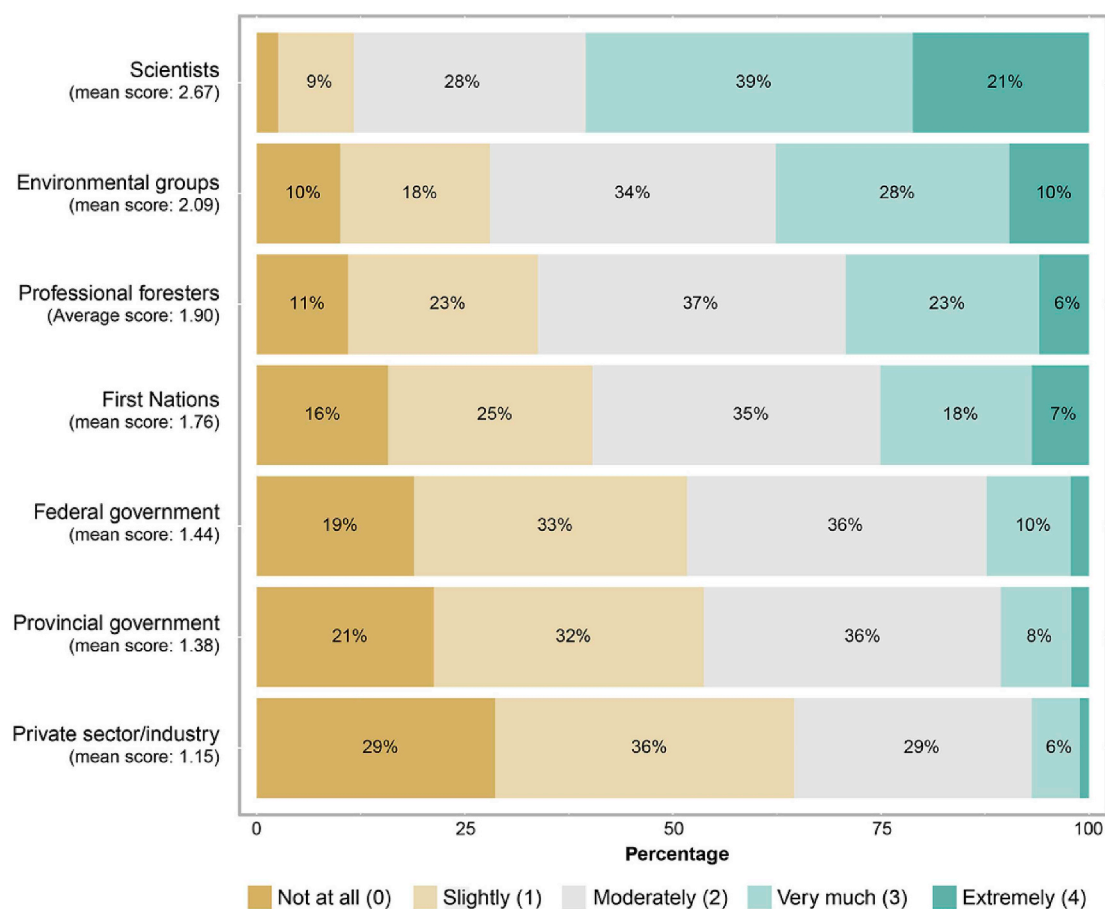


Fig. 3. Trust of different actors to provide accurate information about the implications of climate change for forest management, with 0 = not at all and 4 = extremely.

Table 1

Factor loadings for trust scale items. Loadings in bold indicate that they have been selected in a factor.

	Loading	
<b>Factor 1 – traditional forestry actors (<math>\alpha = 0.76</math>)</b>		
BC's provincial government	0.913	0.178
Canadian federal government	0.830	0.253
Private sector/industry	0.595	
<b>Factor 2 – emergent forestry actors (<math>\alpha = 0.83</math>)</b>		
Scientists	0.213	0.595
Environmental groups	0.144	0.857
First Nations leaders	0.172	0.653
<b>Not included in either factor</b>		
Professional foresters	0.443	0.206

or who had been employed in the forest sector had higher forestry knowledge. A higher perceived threat of climate change and higher education predicted greater trust levels in all actors. Individuals who were employed in forestry and towards the right end of the political spectrum (i.e., conservative) had significantly lower levels of trust in emergent forestry actors and professional foresters, and significantly

higher levels of trust in traditional forestry actors. Respondents who believed that climate change was mostly anthropocentric were more trustful of emergent forestry actors and less trustful of professional foresters. There were also positive statistical relationships between residence in urban centres as well as gender and trust in traditional actors, whereas older individuals were more likely to trust professional foresters (Table 2).

While a majority of respondents supported or strongly supported each type of assisted migration (within and outside of native range; Fig. 4), on average, assisted migration within native range received significantly more support than outside of native range (Mann–Whitney  $U = 1,624,500$ ,  $p < 0.001$ ). Knowledge of forest management and public trust in emergent actors and professional foresters were positively associated with support for assisted migration within native range (Table 3). In contrast, respondents who indicated higher trust in traditional forestry actors were more likely to support assisted migration outside of native range. Respondents who trust decision-makers to choose the interventions that would work in the best interest of British Columbians indicated significantly higher level of support for both type of assisted migration.

**Table 2**

Multiple linear regressions predicting forestry knowledge scores and public trust in traditional and emergent forestry actors and professional foresters. Results include estimated coefficients and standard errors. Bolded results are statistically significant.

Independent variables	Aggregated knowledge	Trust in these actors to provide accurate information about the implications of climate change for forest management		
		Traditional forestry actors	Emergent forestry actors	Professional foresters
Risk perception of CC	0.05 ± 0.06	<b>0.18 ± 0.02***</b>	<b>0.54 ± 0.02***</b>	<b>0.21 ± 0.03***</b>
Cause of CC (anthropocentric)	−0.03 ± 0.11	−0.08 ± 0.04	<b>0.12 ± 0.04***</b>	−0.14 ± 0.06*
Age	<b>0.03 ± 0.003***</b>	0.0002 ± 0.001	−0.002 ± 0.001	<b>0.005 ± 0.002**</b>
Gender (male)	<b>0.69 ± 0.10***</b>	<b>0.09 ± 0.04*</b>	−0.03 ± 0.03	−0.04 ± 0.05
Education	<b>0.11 ± 0.04**</b>	<b>0.04 ± 0.01**</b>	<b>0.02 ± 0.01*</b>	<b>0.04 ± 0.02*</b>
Employment in forestry	<b>0.66 ± 0.21**</b>	<b>0.24 ± 0.08**</b>	−0.13 ± 0.07*	<b>0.16 ± 0.11*</b>
Political (right orientation)	0.003 ± 0.02	<b>0.05 ± 0.008***</b>	−0.05 ± 0.007***	<b>0.05 ± 0.01***</b>
Region (Rural)	0.32 ± 0.17	−0.11 ± 0.07	−0.09 ± 0.06	0.03 ± 0.09
Region (Urban)	−0.35 ± 0.10***	<b>0.09 ± 0.04*</b>	0.04 ± 0.03	0.08 ± 0.05
Region (Suburban)	N/A	N/A	N/A	N/A
Adjusted R <sup>2</sup>	0.08	0.06	0.39	0.05
F value	20.05***	13.95***	132.90***	9.00***

\*p < 0.05; \*\*p < 0.01; \*\*\*p < 0.001.

## 5. Discussion

Three insights arise from our analysis that clarify the roles of trust and knowledge in the context of climate change adaptation in forest management: (1) the consistency of climate risk perception findings and persistent inaccuracies in attribution, (2) the current levels and directionality of public knowledge and trust, and the reasons explaining the observed divergence (i.e., demographic and psychographic factors), and (3) how support for assisted migration operates in this context.

### 5.1. Perceptions of climate change risks: Consistent perceptions, persistent inaccuracies

Our findings on perceptions of climate change risks amongst BC's public are remarkably consistent with previous studies from Canada and BC (Mildenberger et al., 2016), as well as other Western countries (Lorenzoni and Pidgeon, 2006; Spence et al., 2011; Leiserowitz et al., 2017). Specifically, our study and others find that, while there is widespread public awareness and apprehension about climate change, misunderstandings of its anthropogenic origins persist and associated risks tend to be perceived as spatially distant. As the impacts of climate change become more noticeable, a growing awareness of the local and regional threats posed by climate change is likely. For example, increases in the frequency and intensity of natural disasters are being

observed in many regions across the globe (Spence et al., 2011, IPCC 2018). In BC, the recent unprecedented insect infestation (Kurz et al., 2008), wildfires (BC Wildfire Service, 2018) and flooding (Cousins, 2018) have led the government to publicly acknowledge the need for the province to prepare for a “new normal” of flooding and fires (Abbott and Chapman, 2018). While forest-dependent communities experience these impacts first-hand, large urban centres are also increasingly vulnerable (e.g., hazardous air quality due to smoke from forest fires; Quackenbush, 2018; Fayerman and Mahichi, 2018).

### 5.2. Who trusts whom? Who knows what?

The low public trust in government and the forest industry reported by our respondents is consistent with other studies in BC (Tindall et al., 2010, 720, Peterson St-Laurent et al., 2018a) and elsewhere (Nelson et al., 2017; Eriksson et al., 2017; Olsen and Shindler, 2010). The dissimilar levels of trust in different forestry actors suggests that governments and the forest industry would benefit from working more publicly and transparently with a broader diversity of actors (e.g., First Nations, NGOs), for instance through co-management initiatives (e.g., Cullen et al., 2010, Mabee and Hoberg, 2006). The literature on organizational change (Primmer and Wolf, 2009; Schultz et al., 2018) and public engagement (Sheppard, 2005; Peterson St-Laurent et al., 2018c) also suggest that collaborations between diverse actors may benefit the

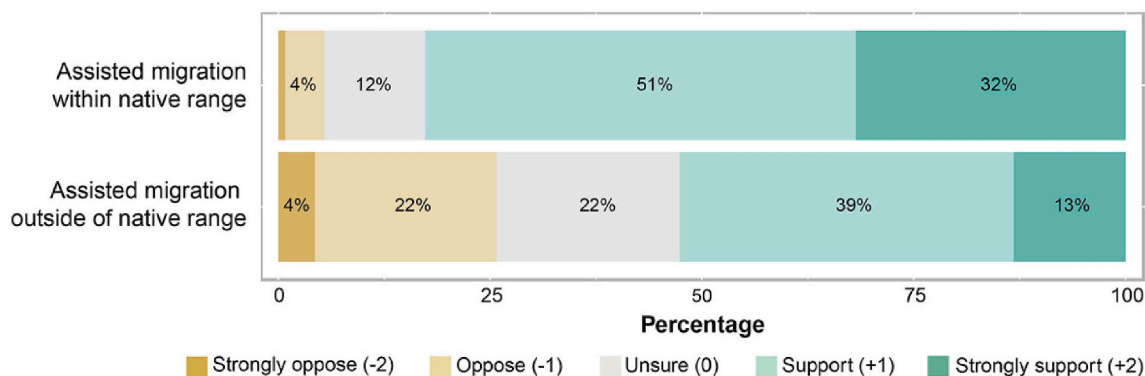


Fig. 4. Levels of support/opposition for both assisted migration within and outside of native range, with −2 = strongly oppose and 2 = strongly support.

**Table 3**

Ordinal logistic regressions predicting the effects of public trust and forestry knowledge on support for the two assisted migration strategies. Results include coefficients and odds ratio in parenthesis. Bolded results are statistically significant.

	Support for AM within native range (−2 to +2)	Support for AM outside of native range (−2 to +2)
Knowledge of forest management	<b>0.15 *** (1.16)</b>	0.003 (1.002)
Trust in this group to provide accurate information about the implications of climate change for forest management		
Traditional forestry actors	0.004 (1.05)	<b>0.28*** (1.32)</b>
Emergent forestry actors	<b>0.12 * (1.13)</b>	−0.02 (0.98)
Professional foresters	<b>0.09* (1.09)</b>	0.03 (1.03)
Agreement with the statement “I trust decision-makers to choose the interventions that would work in the best interest of British Columbians”	<b>0.29*** (1.33)</b>	<b>0.47*** (1.60)</b>
Nagelkerke R <sup>2</sup>	0.07	0.10

\*p < 0.05; \*\*p < 0.01; \*\*\*p < 0.001.

decision-making process around forest management issues—for instance, by increasing trust, credibility and the legitimacy of the resultant policy.

The finding that respondents differentiated between scientists and professional foresters working on the ground (e.g., as trusted) and government institutions or political operatives working on policy (e.g. as less trusted) is consistent with findings from [Shindler et al. \(2014\)](#), who note the importance of distinguishing between public trust in government, or organizational trust, and public trust in individuals, or interpersonal trust. In this study, interpersonal trust relates to trust in field managers, foresters and other experts that are the face of the agency. Because interpersonal trust can sometimes overcome a lack of trust in governments (idem), our results suggest that engagement of professional foresters and scientists working within government agencies with publics may help foster greater trust in management decisions ([Toman et al. 2008, 2011](#); [Schultz et al., 2018](#)).

Our findings on public knowledge of forestry and forest management are similar to related work in the context of forestry. [Harshaw et al. \(2009\)](#) similarly found low levels of forestry knowledge and conclude that this may affect the capacity of the public to effectively engage in decision-making processes around forest management. In partial contrast, unlike [Shi et al. \(2016\)](#), we did not find that varying levels of knowledge (i.e., about different aspects of forest management) had different effects on policy support. However, low levels of knowledge about two aspects of forestry—the overall unfamiliarity with reforestation and the use of genetically modified trees on public lands—stand out as particularly relevant for understanding public support for assisted migration. Notably, respondents often incorrectly believed that genetically modified trees were used in BC's publicly owned forests—a practice that is currently illegal. Considering that recent studies have found strong opposition to GMOs ([Hajjar and Kozak, 2015](#); [Peterson St-Laurent et al., 2018b](#)), the potential for the mistaken conflation of genomics technologies (that do not manipulate the genome) and GMO technologies (that do) represents a potential area of public misunderstanding in the implementation of assisted migration strategies.

While our findings reveal low levels of public knowledge about forestry, this should not be interpreted as evidence that the public is unqualified to participate in technical and scientific debates and decision-making (see [Irwin and Wynne, 1996](#); [Cozzens and Woodhouse,](#)

[1995](#)). Neither should this finding support the reasoning at the root of the debunked knowledge-deficit model of science communication—as still used by some scientists and decision-makers—that “given the facts (whatever they are), the public will happily support new technologies” ([Brown, 2009, 609](#)). Furthermore, because we are unlikely to ever completely understand the potential risks of implementing (or not implementing) assisted migration ([Aubin et al., 2011](#); [McLachlan et al., 2007](#)), focusing on the knowledge-deficit could lead to “an illusion that the deficit can indeed be fixed” ([Brown, 2009, 609](#)).

The regression analyses identified determinants of knowledge that generally align with those previously reported in the literature. For instance, other studies have found that rural residents ([Racevskis and Lupi, 2006](#); [McFarlane et al., 2006](#)), older male and more educated individuals ([Fuller et al., 2016](#); [Williams, 2002](#)) are generally more familiar with different aspects of forest management. On the other hand, determinants of public trust are more complex and need to be considered within the historical context of BC and the important public opinion divide that arose in the 1980s over how forests should be managed ([Luckert et al., 2011](#); [Cashore et al., 2001](#)). Simply put, proponents of conventional commercial harvesting—traditionally, the government and the forest industry—were confronted with a new coalition advocating for more conservation-based approaches ([Pralle, 2006](#)). Because this fragmented political landscape is still relevant to this day, public trust in the context of BC forest management seems to be shaped more by ideology rather than by demographics. This context explains why variables such as political orientation, employment in forestry and views about climate change play significant role in shaping levels of public trust while gender, age and urban/rural residence do not. While these results are highly context-dependent, they may be relevant to other regions of the world with similar histories of contentious and litigious debates over forest management (e.g., US Pacific Northwest; [Ribe and Matteson, 2002](#), [Spies and Duncan, 2012](#)). Our results also demonstrate that professional foresters, who may or may not be directly associated with the forest industry, are seen by the public—in terms of trustworthiness—as somewhat distinct from both traditional and emergent forestry actors. This is indicative of an evolving forest sector in which the public recognizes and values multiple types of expertise.



### 5.3. Linking public trust, knowledge and support for assisted migration

The low levels of public knowledge about forest management and public trust in governments and the forest industry identified here suggest that the widespread implementation of genomics-based assisted migration and other climate-adaptive policy changes in BC's forests may be met with some public resistance. The positive effect of trust on support for assisted migration is consistent with other studies that have shown that public trust plays an important role in determining support for natural resource management decisions and policy (Stern and Coleman, 2015; Lachapelle and McCool, 2012; Olsen and Shindler, 2010; Winter et al., 2004). The results from the ordinal logistic regressions indicate that respondents who trust emergent forestry actors are more likely to support management options that maintains historical natural species distribution (i.e., assisted migration within native range), whereas trust in traditional forestry actors is associated with an inclination towards assisted migration outside of native range. This divergence between emergent and traditional forestry actors highlight once again the persistent divide in public opinion when discussing forest management. The lower trust in traditional forest managers (governments and forest industry)—which has also been noted in the context of climate change mitigation in BC's forests (Peterson St-Laurent et al., 2018a)—could reduce public willingness to accept and/or support new forest management strategies like assisted migration, especially in light of the potential risks associated with implementation (Park and Talbot, 2012; Pedlar et al., 2012).

The relationship between knowledge of forestry and support for assisted migration is more ambiguous; a significant effect on support for assisted migration within native range, but no effect on support for assisted migration outside of native range. For the former, we speculate that respondents with higher levels of forestry knowledge may be more aware of the extent to which seed sources, plantations and forest management, more broadly, already involve high levels of human intervention. This interpretation is supported by recent focus groups in forest-dependent communities (Findlater et al., 2018). For the latter, we note that the scientific community is similarly divided about whether or not to move species beyond their native range, with many experts suggesting the potential for unknown ecological risks (Mueller and Hellmann, 2008). This ambivalence—both in the literature and among respondents—hints at the difficult trade-off between accepting the impacts of climate change on forests and implementing strategies that may improve forest resilience, but that may also lead to negative consequences (e.g., introduction of invasive species or pests; Aubin et al., 2011). Further, given that assisted migration outside of native range likely involves greater ecological risks—many of which do not apply to assisted migration within native range (Hewitt et al., 2011)—knowledge may not be the most important predictor of risk perception and policy support where uncertainties are high and diverse values are at stake, a finding that has been reported elsewhere (e.g., Kahan et al., 2012; McFarlane et al., 2012).

### 6. Policy implications and recommendations for forest management

Our results suggest the need to strengthen both forestry knowledge

and public trust—beginning with trust in governments—to improve the perceived quality of decisions about the design and implementation of genomics-based assisted migration. One way to achieve this could involve the implementation of meaningful engagement with the public and stakeholders during decision-making around complex forest management (and other environmental) issues, for instance, through innovative participatory processes (Rauschmayer and Wittmer, 2006). Importantly, the purpose of such processes should not be to ensure unreserved support for assisted migration, but rather to allow for a participatory, informed, transparent, constructive and deliberative decision-making process, regardless of its outcome in relation to acceptance or rejection for the implementation of assisted migration in public forests.

Citizen engagement processes have been repeatedly identified as instrumental in determining the effectiveness of communications, interactions and trust between the public and managing agencies (Toman et al., 2006; Chilvers, 2007). Such approaches have also been shown to lessen perceived discrepancies between scientific and public knowledge, as well as to increase public awareness (Chilvers, 2007). These participatory efforts are particularly important in an era of 'fake news' and siloed social media (McCartney, 2016). Misinformation around politically charged issues, such as climate change, has the potential to generate public confusion (Barthel et al., 2016) and, as some have argued, act as a deterrent to effective decision making (Tambini, 2017).

Our analysis suggests some specific areas of emphasis for public engagement. For instance, knowing that urbanites have lower levels of knowledge about forest management may help inform communication efforts and engagement materials. Similarly, knowing that politically conservative individuals and those employed in the forest sector have higher levels of trust in government and the forest industry also suggests that efforts to build trust might be well-placed with other actors. Professional foresters may play a crucial role in mediating distrust by more publicly engaging in the design and implementation of forest management plans.

In view of the BC government's expressed intent to implement assisted migration strategies in the near future, it is imperative that the government support effective decision-making by working to foster collective and constructive interactions and to increase trust and reciprocity between the public and other key actors. Considered as a whole, our findings can be used in the development of tailored communication materials and public engagement processes that would foster informed discussions about the potential costs and benefits of assisted migration.

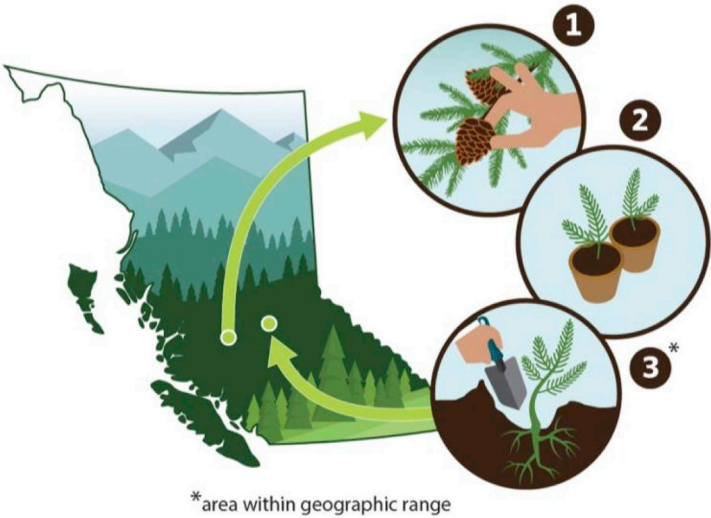
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Appendix 1. Description of assisted migration within and outside of natural range presented in the survey.

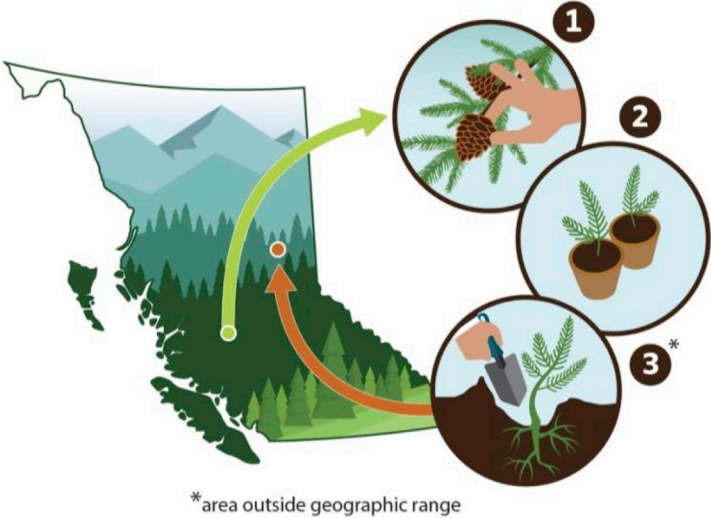
Assisted migration within natural range

(1) Forests would be regrown by collecting seeds from trees that are genetically adapted to anticipated future climatic conditions. (2) These seeds would be used to grow seedlings that are then (3) planted at longer distances from where the seeds originated, but still within the species’ natural geographic range.in that area at that time.



Assisted migration outside of natural range

(1) Forests would be regrown by collecting seeds from trees that are genetically adapted to anticipated future climatic conditions. (2) These seeds would be used to grow seedlings that are then (3) planted outside of the species’ current natural geographic range, in areas that are anticipated to be climatically suitable in the near future as the climate changes.

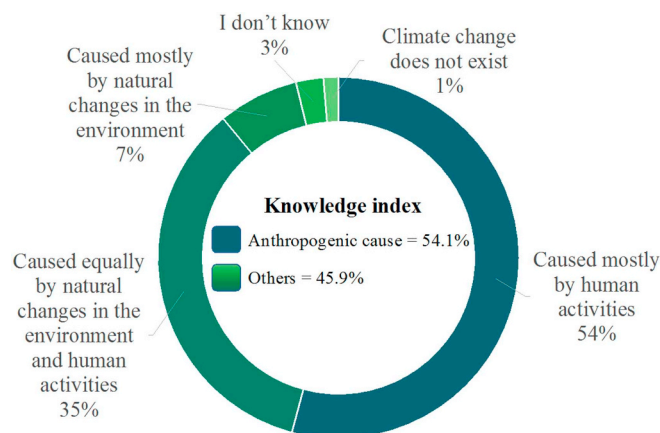


Appendix 2. Overview of participants' demographic information

Variable	#	Percentage
Age		
19–34 years old	461	24.1%
35–54 years old	712	36.9%
≥ 55 years old	749	39.0%

Gender		
Male	871	44.6%
Female	1065	54.6%
Prefer to self-describe	7	0.4%
Prefer not to answer (NA)	9	0.5%
Education		
Elementary school (1)	10	0.5%
High school (2)	350	17.9%
Vocational/technical school (3)	403	20.6%
Some university/college (4)	342	17.5%
Bachelor's degree (5)	518	26.5%
Graduate degree (6)	278	14.2%
Prefer not to answer (NA)	51	2.6%
Employment in forest sector		
Employed (directly or indirectly)	109	5.6%
Not employed	1798	92.1%
Prefer not to answer (NA)	45	2.3%
Political orientation		
0 (left)	70	3.6%
1	102	5.2%
2	171	8.8%
3	182	9.3%
4	173	8.9%
5 (Neutral)	611	31.3%
6	198	10.1%
7	177	9.1%
8	117	6.0%
9	59	3.0%
10 (right)	66	3.4%
Prefer not to answer (NA)	26	1.3%
Region of residence		
Urban	974	49.9%
Suburban	762	39.0%
Rural	190	9.7%
Prefer not to answer (NA)	26	1.3%

### Appendix 3. Respondents' perception on the cause of climate change.



### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jenvman.2019.04.065>.

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